6.2 Question B: Are the Exposure Assumptions, Toxicity Data, Cleanup Levels, and RAOs Used at the Time of the Remedy Still Valid?

Based on the evaluation presented in this section, the exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of the remedy are still valid and revision of the RAOs is not necessary. There were no changes in exposure pathways or assumptions during this FYR period; land use in the COU remains consistent with the Rocky Flats Wildlife Refuge land use assumption in the CAD/ROD. There were some revisions to surface water quality standards and toxicity data, which are discussed in the sections below.

6.2.1 Evaluation of Changes in Standards

A review of the CAD/ROD ARARs was conducted to determine whether there have been any promulgated changes to statutes or regulations relevant to the chemicals, location, and/or action addressed by the CAD/ROD during this FYR period. Appendix H is a table of changes to CAD/ROD ARARs and other potentially applicable regulations that were considered in this FYR evaluation.

The remedy performance standards for surface water and groundwater at the Site are the Colorado surface water quality standards identified as ARARs in the CAD/ROD. These standards are directly relevant to groundwater RAOs 1 and 2, surface water RAO 1, and soil RAOs 1 and 2 (Table 4). The CAD/ROD also identified select Colorado radiation protection standards as ARARs for the Site. Changes to ARARs may impact remedy protectiveness and must be evaluated in the FYR process.

6.2.1.1 Surface Water Standards

The surface water standards applicable to the COU are based on (1) Colorado WQCC regulation # 31, "Colorado Basic Standards and Methodologies for Surface Waters" (5 CCR 1002-31), which are statewide basic standards, and (2) Colorado WQCC regulation #38, "Classification and Numeric Standards South Platte River Basin, Laramie River Basin, Republican River Basin, Smoky Hill River Basin" (5 CCR 1002-38), which are site-specific standards. The Walnut and Woman Creek portions in the COU are Big Dry Creek segments 4a and 5 of the South Platte River Basin. Because the use classification of groundwater in the COU is surface water protection, the applicable surface water standards also apply to groundwater.

The surface water standards for eight chemical constituents were revised within this FYR period (see CR 2012-03). The standards for five of these constituents (acrylamide, carbon tetrachloride, hexachloroethane, nitrobenzene, and tetrachloroethene) increased and therefore, do not affect remedy protectiveness. The standard for *cis*-1,2-dichloroethene was changed to a range of concentrations (0.014 to 0.070 mg/L). As a result of consultation with the RFLMA parties, the higher number in the range (0.070 mg/L) was retained as the RFLMA surface water standard. The higher standard was the same as the previous RFLMA standard for *cis*-1,2-dichloroethene, therefore, remedy protectiveness was not affected. The standards for two constituents (1,4-dioxane and pentachlorophenol) decreased from the previous standards (i.e., are more stringent).

These two constituents were not identified as analytes of interest in any media at the Site in the RI/FS report (DOE 2006a), nor were they identified as COCs in the CRA; routine monitoring for these constituents is not required by RFLMA. Limited data from groundwater and treatment system monitoring during this FYR period show pentachlorophenol as non-detect in all samples; no data for 1,4-dioxane is available. Therefore, a change in the standards for these two constituents does not affect protectiveness of the remedy.

6.2.1.2 Radiation Protection Standards

For radiological sites that do not allow for unrestricted use, as is the case for the COU, Colorado regulations require that institutional controls be in place that reasonably assure that the total effective dose equivalent from residual radioactivity at the site does not exceed 25 mrem/year (6 CCR 1007-4.61.2). In 2006, a dose assessment was completed for the COU using the RESRAD computer model, to determine if the Site met the 25 mrem/year dose criteria upon closure (DOE 2006). For this FYR, changes to input parameters (e.g., slope factors, dose conversion factors) used in the dose assessment were evaluated to determine if this ARAR continues to be met. The methodology used to complete this FYR review of radiological dose is described in Appendix C. In order to understand the relative impact to dose resulting from the numerous changes to input parameters and the computer model that have occurred since 2006, a range of exposure scenarios and associated analytical data evaluated in the 2006 RESRAD (version 6.3) dose assessment were entered into the current RESRAD model (version 7.2). No new sample data were collected to support this fourth FYR dose evaluation.

A comparison of the RESRAD version 6.3 dose results to the RESRAD version 7.2 dose results indicate little change in total dose. All of the 2006 scenarios evaluated in Appendix C yielded similar results, suggesting that the changes in total dose for all scenarios and locations evaluated in 2006 would be negligible using the current RESRAD model version. This simply means that the changes to RESRAD since 2006 have not resulted in major impacts to dose calculated by the model. That is, the dose calculated using RESRAD version 6.3 is nearly the same as the dose calculated using RESRAD version 7.2, using the same 2006 site-specific input parameters. Therefore, because the dose assessment from 2006 indicated that the Site is in compliance with the dose criteria ARAR from the CAD/ROD with a total dose much less than 25 mrem/yr, a recalculation of dose using the most updated version of RESRAD would yield similar results and the ARAR would still be met. The FYR dose assessment review concluded that the dose criteria ARAR continues to be met and the remedy in the COU remains protective.

6.2.2 Evaluation of Changes in Toxicity Data

The remedy performance standards for soil in the COU are site-specific, risk-based values calculated using the exposure assumptions for a wildlife refuge worker (WRW). These standards, referred to as preliminary remediation goals (PRGs), were used to identify COCs at the site and are directly relevant to the evaluation of soil RAO 3 (Table 4). The risks posed by the COCs left at the Rocky Flats Site following accelerated actions were evaluated in a comprehensive risk assessment (CRA) in 2006 (DOE 2006a).

The CRA evaluated the land area that encompasses the POU and the COU, divided into twelve exposure units (EUs) (Figure C-1). The CRA was completed by EU and not by OU (POU and COU). However, the RI/FS and CAD/ROD concluded that the POU was not affected by site activities from a hazardous waste perspective (DOE, 2006a; DOE, EPA, CDPHE 2006). There have been no changes or new information since the CAD/ROD that would alter this conclusion. Therefore, it is assumed that the chemical COCs apply to the COU portion of the site and not the POU. Under CERCLA, the FYR risk assessment review is required for the COU as part of the protectiveness evaluation.

Table 1 summarizes all COCs (chemical and radiological) for each EU for which risks were evaluated in the CRA. These are constituents for which residual soil concentrations exceeded site PRGs.

The PRGs represent concentrations for individual chemical constituents and radionuclides that would equate to a carcinogenic risk of 1 x 10^{-6} or a noncarcinogenic hazard quotient of 0.1 based on the exposure assumptions for the WRW. This risk value represents the added probability of an individual or population of developing cancer during a lifetime as a result of exposure to site contaminants. The acceptable risk range for CERCLA sites is an added risk of less than 1 in 1,000,000 (1×10^{-6}) to a maximum of 1 in 10,000 (1×10^{-4}). The PRGs were developed using toxicity data that were current at the time of the CRA and were developed for exposures to both surface and subsurface soils. Changes to the risk parameters (e.g., slope factors, toxicity data) used to calculate these PRGs may impact remedy protectiveness and must be evaluated in the FYR process.

Table 1

Surface Soil COCs Identified for Each EU in the CRA

	Exposure Unit											
Constituent	**Industrial Area EU**	**Upper Woman Drainage EU**	**Wind Blown EU**	**No Name Gulch EU**	**Upper Walnut Drainage EU**	**Lower Woman Drainage EU**	**Rock Creek EU**	**Lower Walnut Drainage EU**	**Inter Drainage EU**	**West Area EU**	**Southwest Buffer Zone Area EU**	**Southeast Buffer Zone Area EU**
Arsenic	X	-	X	-	-	-	-	-	-	-	-	-
Vanadium	-	-	-	X	-	-	-	-	-	-	-	-
2,3,7,8-TCDD	-	X	-	-	-	-	-	-	-	-	-	-
Benzo[a]pyrene	X	X	-	-	X	-	-	-	-	-	-	-
Plutonium 239/240	-	-	X	-	-	-	-	-	-	-	-	-

"X" = constituent designated a COC in the 2006 CRA.
"-" = constituent not designated a COC in the 2006 CRA.

6.2.2.1 Chemical Constituents

The COC identification process used in the CRA was reviewed using updated EPA soil screening values comparable to the WRW PRGs. Generally, the evaluation confirmed that the surface soil COCs identified in the CRA remain the primary risk drivers at the site. It also confirmed that there are no subsurface COCs. The toxicity data for the COCs were reviewed by comparing current toxicity data with that used during the CRA. A comparison of the CRA and current toxicity data is provided in Table 6.

There have been some changes in toxicity data since the CRA; however, these do not affect the protectiveness of the remedy. EPA has revised their methodology for determining risks associated with the inhalation pathway for both carcinogens and noncarcinogens. However, for chemical constituents, this pathway is of much lesser importance for the WRW than the oral ingestion pathway, and does not impact the estimation of overall site risks. The toxicity data for the oral ingestion pathway has not changed for arsenic and benzo(a)pyrene. The EPA oral reference dose for vanadium is higher than that used in the CRA, meaning that current estimated risks would be lower. A new reference dose has been added for dioxin (2,3,7,8-TCDD) since the CRA. However, the elevated concentrations of dioxin were associated with the OLF prior to construction of the cover and are no longer at the surface. Thus, the pathway to residual dioxin contamination has been severed and changes in toxicity data do not affect remedy protectiveness.

Table 2
Comparison of COC Toxicity Values

COC	Carcinogenic Toxicity Values				Noncarcinogenic toxicity values			
	Oral/Ingestion[a]		Inhalation		Oral/Ingestion[d]		Inhalation	
	CRA	Current	CRA[b]	Current[c]	CRA	Current	CRA	Current[e]
Arsenic	1.50E+00	1.50E+00	1.51.E+01	4.3E-03	3.00E-04	3.00E-04	n/a	1.5E-05
Vanadium	n/a	n/a	n/a	n/a	1.00E-3	9.00E-03	n/a	n/a
Benzo(a)pyrene	7.3E+00	7.3E+00	3.1E+00	1.1E-03	n/a	n/a	n/a	n/a
2,3,7,8-TCDD	1.5E+05	1.3E+05	1.5E+05	3.8E+01	n/a	7.0E-10	n/a	4.8E-08

[a]oral slope factor $(mg/kg\text{-}day)^{-1}$
[b]Inhalation slope factor $(mg/kg\text{-}day)^{-1}$
[c]Inhalation unit risk $(ug/m^3)^{-1}$
[d]Oral Reference dose (mg/kg-day)
[e]Reference concentration (mg/m^3)

6.2.2.2 Radionuclide Constituents

Information from the current EPA PRG calculator was used in this FYR evaluation to determine if the risk from radionuclides to the WRW in the COU remains within the acceptable CERCLA risk range. The acceptable risk range for CERCLA sites is an added cancer risk of less than 1 in 1,000,000 (1×10^{-6}) to a maximum of 1 in 10,000 (1×10^{-4}). The risk value represents the added probability of an individual or population of developing cancer during a lifetime as a result of exposure to site contaminants. Information in the EPA PRG calculator includes the numerous changes to toxicity factors that have occurred since 2006, including revisions specific to plutonium and uranium. A summary of the methodology used and these changes, including changes to slope factors for the different exposure pathways is provided in Appendix C. For

completeness, this FYR review considered Pu-239/240 (the only radionuclide COC identified in the 2006 CRA), Am-241, U-234, U-235, and U-238. The americium and uranium isotopes represent the other primary radionuclides associated with Rocky Flats historical operations.

To perform this FYR radiological risk evaluation, information from the 2017 EPA online calculator was used as a basis to generate site-specific PRGs using the input parameters from the 2006 CRA for the WRW at a 1 x 10^{-6} risk level. These values were then compared to the PRG WRW values in the 2006 CRA, which were also calculated at the 1 x 10^{-6} risk level. This methodology does not require input of site-specific analytical data. As such, no new analytical data were collected for this FYR evaluation. Details of the methodology used to complete this FYR evaluation are presented in Appendix C.

As evidenced in Table 7, the PRGs calculated for this FYR evaluation are slightly higher than those calculated for the 2006 CRA. This means that the surface soil in the COU may contain slightly higher concentrations of radionuclides and still be protective at a 1 x 10^{-6} risk level (i.e., the risk of residual radionuclides at the site has not increased). The differences is likely attributable to changes in the slope factors and/or equations used in the 2017 PRG calculator. Therefore, while numerous changes have occurred to the EPA PRG calculator since 2006, the risk to the WRW from residual radionuclides in the COU is effectively the same as it was in 2006 (1 x 10^{-6}), and well within the acceptable risk range.

Table 3
PRG Comparison for WRW in the COU
(pCi/g at 10^{-6} risk level)

Isotope	2006 CRA PRG	2017 PRG
Am-241	7.69	8.81
Pu-239	9.78	11.85
U-234	25.31	29.96
U-235	1.05	1.06
U-238	29.33	34.38

6.2.3 FYR Risk Evaluation Summary

The chemical and radiological risks to the WRW in the COU were reviewed in light of changes to toxicity factors that have occurred since the CRA was published in 2006. Following are the key conclusions from this FYR risk evaluation:

- The risks posed to the WRW in the COU for chemical and radiological constituents remain within the acceptable risk range.
- The changes in toxicity values and other input parameters did not affect the protectiveness of the remedy.
- Exposure assumptions used are conservative and remain valid.

- The general Site Conceptual Model and assumption that the most likely exposure scenario for a human receptor is approximated by a WRW scenario is still valid for the COU.
- Institutional controls are in place at the COU that eliminate the vapor intrusion pathway.
- RAOs and cleanup goals remain valid.

Independent of the FYR risk evaluation of the COU described above, a review of risks in the POU and OU3 was also completed. This review confirmed that the unlimited use and unrestricted exposure (UU/UE) determinations for the POU and OU3 are still valid. A summary of the review methodology and results is presented in Appendix C.

6.2.4 RAO Status

The status of each RAO during this FYR period is presented in Table 4. The RAOs and ARARs in the CAD/ROD remain relevant in addressing residual contamination and potential exposure pathways at the Site and assessing remedy protectiveness. Not all RAOs were met during this FYR period, however, the remedy is designed to achieve all RAOs in the long-term. No revisions to the RAOs established in the CAD/ROD are recommended.